Biomedicine

Most blood plasma use not needed

In the last decade, the use of blood plasma transfusions for patients undergoing cardiac surgery or treatment for shock, blood deficiencies and other disorders has increased 10-fold. Yet there is little scientific basis for its widespread use. In response to this trend, a medical advisory panel at the National Institutes of Health in Bethesda, Md., has urged doctors to cut the use of blood plasma.

Plasma is the fluid medium of the blood that contains clotting factors and other proteins as well as some nutrients. Its ready availability from blood banks as "fresh frozen plasma" may have contributed to its widespread use by doctors. Instead of transfusing plasma with its array of components, the panel recommends that doctors administer the specific purified component a patient may need. Plasma, they say, should be reserved mainly for patients with certain clotting and immune factor deficiencies.

Ninety percent of blood plasma use today is unwarranted, says panel chair James L. Tullis of Harvard University Medical School, and the overuse can contribute to the risk of viral infection, since plasma is commonly transfused with red blood cells from another donor, doubling the possible sources of infection. Of the yearly 3.5 million U.S. recipients of any blood product, 3 to 10 percent develop hepatitis from viruses that go undetected in screenings. The risk of blood-transmitted AIDS, or acquired immune deficiency syndrome, is a "possibility," according to the panel. About 1 percent of all reported AIDS cases have been linked to transfusions.

Citing the difficulty of changing current clinical practice, the panel of doctors, blood specialists and public representatives also called for new ways to educate clinicians about transfusion use.

For want of a mightier mouse

To ancient Greeks, a Chimera was a mythological fire-breathing female with the head of a lion, the body of a goat and the tail of a dragon. To researchers at the University of California at San Francisco (UCSF), mouse chimeras — made by merging embryos of two different strains — may hold the key to important new insights into the mechanisms of Down's syndrome, the most common birth defect associated with mental retardation.

Down's syndrome, which results from an extra chromosome 21, affects more than one newborn in a thousand. In addition to mental retardation, victims suffer from heart defects, are susceptible to infection and are at greater risk for leukemia.

Speaking at the National Institutes of Health, Charles Epstein explained how he and co-workers at UCSF had successfully built four years ago the first mouse model of the disease (SN: 8/16/80, p. 104). The scientists linked three genes on a small chunk of the human chromosome to a similar portion on mouse chromosome 16, and found that when they bred mice with an extra number 16, some of the same problems — heart and immune system defects, for example — showed up in the fetuses. But the model was incomplete; the mouse fetuses didn't survive birth. "We were limited," Epstein says. "We could study immune system deficiencies, but we couldn't look at behavior or things closer to nervous system functions that might relate to mental retardation."

Epstein believes he has found a solution. By genetically combining normal mouse embryos with embryos that have an extra chromosome 16, he has created live animals with two different populations of cells — half with the extra chromosome, half without. The physical characteristics of the disease, such as a sloping forehead and slanting eyes, don't show up in the hybrid mice, but they may have immunological problems, Epstein notes.

The chimeric model may also help researchers to better understand the neurochemical and physical changes associated with Alzheimer's disease, a degenerative brain disorder. Scientists don't know why, but Down's syndrome victims over the age of 35 almost always develop Alzheimer's. By studying the abnormalities underlying Down's syndrome, Epstein points out, researchers may indirectly gain some insight into the causes of Alzheimer's disease.

Technology

Free electrons for powerful lasers

Electrons radiate light when they are accelerated. If free electrons (those not attached to any atom) charge through a carefully arranged array of magnets that forces them to wiggle back and forth as they travel, the electromagnetic radiation emitted by the electrons and reflected between mirrors can reinforce itself to create a coherent, single-colored light beam. The result is a free-electron laser.

First reported in 1977, these lasers are starting to become important research instruments. Recently, physicists at the University of California at Santa Barbara (UCSB) announced the development of the first powerful, tunable free-electron laser to operate in the far-infrared region of the spectrum.

The UCSB laser generates infrared light at wavelengths between 0.1 and 1 millimeter. By tuning the laser light to particular wavelengths within this range, researchers can study the motions of atoms and molecules, particularly in solids and liquids. Free-electron lasers at a few other laboratories worldwide can also emit far-infrared light but only over a very narrow range of wavelengths.

The laser opens a "genuinely new frontier where there are basic problems in physics and chemistry that, until now, have been beyond reach," says UCSB physicist Daniel W. Hone. The university expects to open their facility to scientists from across the United States for the study of materials and other basic research topics.

A triple hit for surface atoms

A laser-based technique that theoretically could detect the presence of a single atom of any element contaminating the surface of, say, a silicon wafer is being developed at the Argonne National Laboratory near Chicago. The technique, called SARISA ("surface analysis by resonance ionization of sputtered atoms"), is already about 1,000 times more sensitive than current, widely used methods for detecting impurities in semiconductors, says Argonne's Dieter Gruen, who heads the team of scientists developing the system.

The technique depends on the fact that different types of atoms absorb light at characteristic frequencies. First, a beam of accelerated particles strikes the surface of a sample in a vacuum chamber, knocking atoms off the surface. Then, as the atoms drift away, laser light, which is precisely tuned to affect electrons within only one type of atom, excites electrons from their initial energy state to a higher one. A second laser beam, which is tuned to give the excited electrons just enough extra energy to escape, turns the target atoms into positively charged ions. These ions can then be collected and counted, and any impurity detected.

Says Gruen, "We are making refinements that could make it 100,000 times more sensitive than other methods." But this is still far from detecting the presence of a single atom.

Pinpointing accurate atomic positions

High-resolution electron microscopy combined with image processing by a computer can allow researchers to determine the positions of metal atoms in a thin crystal of an inorganic substance to an accuracy of 0.1 angstrom, reports a team of Swedish scientists from the University of Stockholm in the Sept. 20 NATURE. Although the crystal has to be thin and uniform with minimal variations in thickness, structure and orientation, no previous information about the crystal structure is needed in order to use the method.

The process involves converting the dark and light areas of an electron diffraction pattern from a crystal into digital form. A computer manipulates the data, taking an average over the repeated units into which the atoms are organized within the viewed area, to reduce any "noise" (extraneous signals that obscure the original image) to a low level. This noise reduction step allows atomic positions to be determined accurately.